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MANUAL CONTROL OF RED ALDER WITH CLEARING SAWS

OPERATIONS REPORT AND EQUIPMENT ASSESSMENT

MICHAEL CONWAY-BROWN

NO-CHEM-DO
CONTRACTING AND CONSULTING
RR3 NASSACHUCK ROAD
POWELL RIVER, B.C.
V8A 5C1

PREPARED UNDER CONTRACT TO

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1. INTRODUCTION

The Okeover research project and operational trials (SX-83701 V), initiated in the summer of 1983 by the B.C. Forest Service, was designed to quantify several parameters affecting the resprouting of red alder, a major problem species in the Pacific Northwest. The project expands on similar research by the USDA Forest Service that found a very significant decrease in resprout activity with optimum timing and height of cut.[1] Other recent research from the Department of Natural Resources in the state of Washington confirms a significant variation in resprouting of red alder from timing of cut.[2]

The cutting operation was funded by the federal New Economic Expansion and Development program (NEED), with sponsorship by the Lund Community Club. The research operation was handled by the research staff of the Vancouver Region of the B.C. Forest Service assisted by the NEED crew and District Office personnel.

Concurrent with the increasing public pressure against the use of herbicides in forestry, user agencies have shown renewed interest in alternative non-chemical techniques. A variety of manually-operated or power cutting tools are available for brush control. These include shears, machetes, the Sandvik brush axe, chainsaws, girdling tools, and clearing saws.

The clearing saw (sometimes called a brushcutter) has seen increasing interest and implementation in B.C. It resembles a large "weedeater", hangs from a harness worn by the operator, and has a circular sawblade at the end of a boom. Designed in Sweden as a safer and faster alternative to chainsaws, the clearing saw was ideal for the Okeover trials, particularly to achieve one major parameter: cutting as close to the ground as possible.

This report is about the operations of the Okeover research project and was written by the Operations Manager. It includes observations and analysis on the use of clearing saws for releasing conifer plantations from deciduous competition.

It also includes discussion, review and assessment of both equipment and technique, with recommendations for efficient clearing saw operations. Any opinions expressed are those of the author.

The research report on the Okeover trials is available from the B.C Forest Service:

SX 83701 V

Effect of Timing on the Success of Mechanical Cutting of Red Alder - Operational Trial
- F.T Pendl and B.N. D'Anjou

B.C. Ministry of Forests
Vancouver Forest Region
4595 Canada Way
Burnaby, B.C. V5G 4L9

2. CLEARING SAWS

2.1 Equipment Selection

There are essentially two styles of heavy-duty rotary clearing saws: the Swedish "clearing saw" (Husqvarna and Jonsereds) designed specifically for forestry work, and the Japanese "brush cutter" (Shindaiwa and other makes), more suited for brush. The two designs are distinctly different, and as such, are suitable for quite different applications.

Prior to the project, the author investigated makes and models of saws to determine which would be most suitable for the size of alder encountered (1 1/2 to 5 inches in diameter). After reviewing what was available, a request was made for the Husqvarna 165R, a powerful machine with a good reputation. Unfortunately, a smaller and cheaper Japanese saw (Shindaiwa B-40) was substituted without any consultation with the project sponsors. This proved to be a major handicap for the duration of the project.

The project was started with 4 leased saws supplied by the District Office: 2 Husky 165's and two Stihl FS08's. They were later replaced by the Shindaiwas.

The problems with keeping the Shindaiwa saws functional at all times became excessive. It was the generosity of two distributors of Swedish saws, Pacific Equipment Co. and Josa Incorporated, that allowed the project to continue by supplying three demonstration saws for assessment and use.

During the project we had the opportunity to use and assess seven different makes and models of clearing saws. A review of each is covered in section 2.3 of this report.

2.2 Design Features

2.2.1 Blades and Guards

The function and work technique of a clearing saw is highly affected by blade size. Surprisingly, the smallest saw (Shindaiwa) comes with the largest blade. The Swedish saws can use either an 8-inch or 9-inch blade, depending on the model. The Shindaiwa comes with a 10-inch blade (the sales brochure states that 12-inch is standard, and claims it can throw a 14-inch blade).

The Shindaiwa was tried with a 12-inch blade (Stihl, 50-tooth, bored to fit the larger Japanese arbor) and was found to be an extreme mismatch. It would take up to 30 seconds to get the blade up to speed and then about one minute to wind down. A tremendous amount of energy would get stored in the spinning blade. Extreme kickbacks were quite possible and having to move with the blade always "on" was hazardous. Although there may be room for a 14-inch blade behind the guard (as advertised), the result would be a severe mismatch.

Maximum blade size is limited by the size and position of the blade guard on the saw. The Swedish saws all have small, close-fitting guards of cast aluminum and can only take one size blade. The Shindaiwa (and most Japanese saws) have a large plastic guard well back from the blade, thereby accommodating a range of blade sizes. The larger guard proves to be very frustrating in use; it tends to hang up on brush. By contrast, the Swedish designs with their "form fitting" blade guards rarely get hung up.

The superiority of design details (such as blade guard) characterize the Swedish saws of far greater sophistication and ease of operation than the Japanese designs.

2.2.2 Power

For up to 2-inch stems, the Shindaiwa had adequate power, but the

larger stems produced no end of frustration. Control of the saw, work technique, and cutting a stump as low as possible all suffered and became of secondary priority.

The Shindaiwa does not have sufficient torque to keep a 10-inch blade feeding through a 3"+ stem unless a perfectly sharp blade is used - a rare situation when working close to the ground. One has to rely on the energy stored in the spinning blade to carry through the cut. The Shindaiwa saws, with less power and a larger blade, are far more likely to bind and stall, often resulting in a tightly-pinched blade that can be difficult to extract. The technique that evolved was to enter the cut at full blade speed with a swing that varied with the dullness of the blade and the thickness of the stem. Often several attempts were neccessary. Kickbacks, stalled and stuck blades, and hitting rocks were a common occurence. Proper directional falling was difficult, if not impossible, to attain.

Swinging the saw at the tree placed an inordinate strain on the drive train causing numerous broken drive shafts. However, faced with 20 hectares of alder to cut with an inadequate saw left little choice but to use whatever technique worked.

The more powerful Swedish saws with their smaller blades almost always had the power and torque to "motor through" a cut, even with a dulled blade when necessary.

2.2.3 Balancing the Saw

The Shindaiwa saw as supplied will not balance properly. The bracket has four hanging positions, but even on the most forwardly position, the saw is still "nose heavy". With the 12-inch blade the balance problem becomes far worse. The Swedish saws, however, have a continuous adjustment and can easily be balanced for any situation.

2.2.4 General

The Swedish approach has been to develop and design both work technique and tool together, producing both efficiency and utility.

Subtle design features are often overlooked until revealed by actual work experience. Vines, ferns, bracken, and brush abound in our typical "west coast rainforest". The Shindaiwa saws tend to get hooked by the protruding air cleaner, throttle lever, choke lever, prime lever, stop switch and blade guard. By contrast, the Swedish saws are fully encased and seldom get snagged.

2.2.5 Cutting Angle

The angle that the leading edge of the sawblade approaches the ground is designed differently for the two types of saws. The Swedish saws are all designed to approach the cut at about 30 degrees with the ground. This angled approach is an integral element of work technique to control the direction of fall. It also allows a straight on approach of the blade when working uphill, the preferred mode on steep terrain.

The Shindaiwas are designed with the blade parallel to the ground which makes it more difficult to achieve directional falling. Perhaps even more frustrating and hampering to efficient work technique is the effect when working uphill; the gangly blade guard becomes the lowest part of the saw and is the first to approach the cut. When lifted to cut uphill, or on a high clearing cut, the blade then approaches the cut almost on its face, rather than on its edge, making such a common and necessary maneuver difficult, awkward, and occasionally impossible.

It should perhaps be emphasized that the parallel arrangement of the blade is desirable in certain applications. On level terrain, the cutting of brush, grass, thickets and other light uses could all be better accomplished with the Japanese style of saw, called a "power scythe" in some sales literature - a very apt description. With its

light weight, wide blade, dependable motor, and low cost, the Shindaiwa saw could be a better choice than the heavier and more costly Swedish saws for such applications. However, with the optional high handlebars and an assortment of attachments, the Swedish saws can be lowered to achieve the parallel-with-the-ground configuration.

2.2.6 Saw Geometry

The geometry is also distinctly different for the two classes of saws. The brush saw, integral to its design, is carried on one side of the body (invariably the right) and the position of the handles should counter that offset. The Swedish models place the right handle close to the central shaft and extend the left handle. A wide range of adjustment allows a relaxed, comfortable, and natural stance - a balanced position. By contrast, the Japanese saw has both handles centered across the boom with a small range of adjustment. This produces an uncomfortable and unnatural stance with the workers' arms cocked to their right side.

2.2.7 Reliability

The last area of comparison between the two types of saws is sturdiness. The more expensive and heavier Swedish products are far more robust than the Japanese saws. Where the Japanese manufacturer uses plastic, the Swedes use cast aluminum; a flimsy pressed-tin sparkplug protector contrasts with a cast alloy case. The boom tube on the Swedish saw is about twice the diameter and several times as stiff as the Shindaiwa. In general, the Husqvarna and Jonsereds (another Swedish design) exhibit better quality materials, design and features.

None of the Swedish saws were used for a long enough time to draw any conclusions about frequency of repair. All saws broke down at some time, especially the used demo saw. Most of the problems with the new saws were easily repaired without the need for replacement parts. However, a good stock of parts for field servicing of saws is recommended for all makes and models.

2.3 Makes and Models Assessed

There are two styles of clearing saws identified by their country of design and manufacture: Japanese and Swedish. The exception is the German-built Stihl, with a Japanese-style design. General discussion of the two classes and specific discussion of each model follows, ending with a comparison to the chainsaw.

2.3.1 Japanese-style Clearing Saws

(i) Shindaiwa B-40 Summary:

-Too long (would be easier to handle in brush with a shorter length, but would also be more hazardous).

-Blade guard too large - hangs up on brush.

-Underpowered (for larger than about 3-4 inch diameter alder).

-Blade size is mismatched to power.

-Poor acceleration - takes too long to come up to speed.

-Drive shaft housing too flimsy.

-Harness buckle comes undone in use, posing a real hazard to workers.

-Improper balance - the hanger does not have the correct range of adjustment. (When a makeshift clamp is positioned on the housing at the proper balance point, a very noticeable improvement in handling and work technique results).

-Rotation locking clamp is too flimsy - should not be made of plastic.

-Too many exposed cables and clips to hang up in the bush. Should be enclosed and clean.

-Needs a protector plate between harness clip point and leg.

-Engineering of engine seems excellent: starts very well and is very dependable.

-Head and spark plug protector far too flimsy - most got distorted from use.

-Gear heads get quite hot in use - 250 degrees plus.

-Throttle control design hooks brush very easily while being carried.
-Harness is comfortable, however, it needs a shorter range of adjustments to get the saw higher to increase the angle with ground.
-Allen screws used for connectors are excellent.

(ii) Stihl Forest Saw - (FS 08)

The Stihl is similar to the Japanese-designed saw with the parallel-blade geometry, except it is far heavier and more powerful. The engine is actually a chain saw (Model 08) that bolts onto the clearing saw frame. It also uses a 10-inch blade, (can accommodate a 12-inch blade), has a larger-than-optimum blade guard, and is similarly "gangly" in the bush. With a good harness, on level terrain, for clearing thickets and brush, the Stihl may have some application. For conifer release in rugged west coast terrain the saw could not be recommended.

(iii) Shindaiwa BP-35

This saw is different in design than all other saws assessed: the motor is mounted on a backpack frame and the boom connects through a flexible drive shaft.

It was only assessed for a very short period of time with the general consensus that it was unsuited to forestry applications.

Response from the crew included the comments that it was very underpowered (the flex drive would absorb considerable power), and the boom was heavy and would result in higher operator fatigue.

One possible application in hardwood control would be as a power source for a cutting head used as a girdling device for larger broadleaf trees. Such a tool, called the "Little Beaver", was developed in the early '50's and was available until about 1970.

2.? 2 Swedish Saws

W had the opportunity to assess three saws manufactured in Sweden: two Husqvarnas (244R and 165R) and the Jonsereds RS 45. All are very similar in design. In fact, from the beginning of the boom to the blade they are essentially identical and many parts could be interchanged between the two makes.

All of the Swedish saws gave some difficulty with the throttle control connections; they are quite vulnerable to being pulled out of their clamps and then require reassembly and readjustment.

The Swedish saws are all highly recommended for forest clearing applications. None could be identified as consistently superior to the others. Variations in crew preference reflected that, with almost everyone preferring a different saw.

(i) Husqvarna 244R

This is the most recent design from Husqvarna and the quietest saw of all. It had less power than the other two, but the power was considered adequate and was well matched to blade size. One design feature that was unique to this model was the integration of the on/off switch with the thumb-controlled throttle. This proved to be bothersome as it had a tendency to switch itself off accidentally if one's thumb slipped off the spring-loaded throttle lever. Because clearing saws cannot be started while mounted on the harness, it becomes necessary to remove the saw before restarting. With experience this idiosyncracy could be avoided most of the time. A highly recommended saw.

(ii) Husqvarna 165R

This is the largest and most powerful of the clearing saws. It is also the heaviest saw but that was not considered to be a problem. Several crew members preferred it over the others because of the larger blade

size (9-inch versus 8-inch) with the power to match it. Weight was less of a contribution to worker fatigue than several other design factors, and with the comfortable Husqvarna harness, the saw was easily carried. Highly recommended.

(iii) Jonsereds RS 45

This saw is the noisiest of all and appears to have more power than the Husky 244R with similar engine displacement. It is a high-revving engine and has a tendency for screws to vibrate loose. A thread-locking compound such as Lock-tite will easily solve that problem.

There were several idiosyncracies in the design that could be improved, such as the difficult-to-access air filter. Several chainsaw designs could be easily adapted to provide one thumb-nut access with no spring-loaded "fallout" parts. A highly recommended saw.

2.4 Parts and Service

Availability and delivery time of parts is a major consideration in choice of saw. Although our experience with the Swedish saws was too short to assess this important consideration, the experience of others[3] indicates that, in Canada, the Husqvarna distributor can provide far better parts service than the Jonsereds distributor.

2.5 Chainsaw vs Clearing Saw

Because of the difficulty of falling the alder with the Shindaiwa saws, chainsaws were occasionally used, particularly for the larger stems (5-inches or over). In general, they were found to require a far greater effort to operate than a clearing saw. This reflects mainly the position used: stooped over with a chainsaw vs standing erect with the clearing saw. The harness supports the weight of the clearing saw comfortably on the shoulders while the weight of the chainsaw is born entirely by the operators' arms. This concurs with the conclusions of the Swedish experience comparing the efficiency of both types of tools.

A clearing saw is a superior tool to the chainsaw for clearing ferns and brush around a tree to be cut. One also doesn't need to get as close with a clearing saw, and often the boom can reach into a tight place to make a cut that would require more clearing to get at with a chainsaw.

Another advantage of the clearing saw is that the blades can take several bites of rock and dirt and yet still cut (albeit not as efficiently), whereas one bite of dirt by a chainsaw requires ten to fifteen minutes of sharpening before it can again be used. Working to the close tolerances that we were attempting to achieve was extremely impractical with a chainsaw.

The hazard from kickbacks with a clearing saw is far less than that of a chainsaw. A clearing saw always kicks to the right, safely away from the operator, whereas the chainsaw kicks back towards the operator.

In general, when working within its limits on suitable terrain, a clearing saw will be faster and safer with less operator fatigue. However, it is recommended that a small chainsaw be kept on site for the occasional oversize stem.

3. SAW BLADES

3.1 Introduction

Next to the saw itself, the most important piece of equipment is the sawblade. Many different types of blades were assessed throughout the project. Methods to sharpen and set the blades were experimented with and an efficient system was developed.

Initially, considerable difficulty was experienced with the blades supplied; they appeared to be a major fault or weak point in developing a close-to-the-ground treatment method.

Despite efforts to the contrary, striking the ground and rocks was a common occurrence for the following reasons:

-initial inexperience with the saws and their technique.
-many areas had extensive low ground foliage, obscuring the operators vision.
-we were cutting as close to the ground as possible. Extensive scarification had left many rocks sitting above the ground in an already rocky site.
-kickbacks (i.e. sideways) were common, particularly with the Shindaiwa saws with their larger blades.
-work technique with the underpowered Shindaiwa often required swinging the saw at a stump to utilize the energy stored in the spinning blade rather than trying to "motor through". The resulting carry-through and kickbacks increased the incidence of blade damage.

The overall result was very hard on blades, and proved to be a major obstacle to efficient operations.

3.2 Blade Types

There are two general classes of blades: those that can be sharpened in the field, and those that must be sharpened off-site with grinding equipment.

3.2.1 Field-Sharpenable Blades

The first includes the Husqvarna "Maxi-blade", Sandvik safety blade, and the Stihl equivalent. They are designed to be resharpened in a similar manner as sawchain using a round file and/or flat file. Problems arise when rocks get hit because the wear comes off the top of the tooth and the entire flat top of the tooth must be filed down as well. It takes far too long to file a damaged blade in the field (approximately 1/2 hour), and tooth life is short, particularly with

the Sandvik safety blade. The Sandvik incorporates a raker tooth in front of the cutter tooth to limit tooth bite and consequently kickbacks. This appears to be a redundant feature and leaves a small cutter tooth with a very short life.

This type of blade is not recommended for use in rocky sites or cutting close to the ground, but where such damage can be avoided it may be practical. It would be best to change blades when damaged and resharpen where a saw vise is available. A vise could be mounted on the crew truck.

3.2.2 Non-Field-Sharpenable Blades

The other style of blade uses the more common hooked tooth as found on most circular saw blades. These were found to be the most satisfactory under our working conditions.

There are several manufacturers offering a 10-inch, 80-tooth pruning blade as an after-market product for the Japanese brush saws with their 1-inch arbor. They cut very fast when sharp and set, but lose their set quickly with wear because of the relatively small size of the teeth. Although these blades are not designed to be resharpened, they can be, using an abrasive metal-cutting disc. These blades will not fit the smaller 20-mm arbors of the Swedish saws.

Surprisingly, the only manufacturer offering a large-toothed blade (50 teeth) to fit the 20-mm arbor is Stihl. However, it is only available in 10 and 12-inch sizes, both too large for the Swedish saws.

A wide selection of blades are available for circular and table saws with a 5/8-inch arbor. They can be rebored at a machine shop to fit the 20-mm arbor, at a cost of from $3-$5 per blade, depending on the number to be done. The author has successfully rebored several blades using an abrasive cone with a round file for touch up.

The best blades appear to be regular circular saw blades with a radical set and 30-40 teeth. They will continue to cut after considerable abuse, are inexpensive, and can quickly and easily be resharpened and set many times.

3.2.3 Carbide Blades

The use of carbide blades to reduce sharpening time was suggested, and to a limited extent, experimented with. Because of dire warnings about using carbide where it can contact rock (carbide is very brittle), only one unique blade design was tried - the inexpensive Credo Enduro with six flat chisel teeth designed to take a limited bite. The carbide blade cut slower and was consequently more controllable than steel blades, but kept a usable edge for only about 6-7 hours of saw time. Rocks were the demise of such blades, and because they are not resharpenable, must be discarded after one use. Not recommended where contact with the ground is likely.

However, where contact with the ground can be avoided, carbide blades will last far longer than steel blades and may offer significant savings in time normally spent sharpening blades in the field. Blades specifically manufactured for clearing saws are now available from the Husqvarna distributor that were not assessed during the project.

3.3 Saw Set

Almost without exception, the stock blades come with inadequate set and require adjustment. A bit of experimenting found that a saw kerf of 2-3 times the thickness of the blade is optimum. This seems to be quite a radical set on first appearances, but the ability of a blade to cut and keep cutting after wear is as dependent on the set as on the sharpness. The sharp points of a saw are quickly lost when working close to the ground, and the resulting decrease in set causes the saw to bind in the cut. With an exaggerated set, the blade will give much longer service between sharpenings, except when there is a mismatch between blade size and engine power such as with the Shindaiwa.

Several saw sets were tried: Sandvik 111B, Stanley 42S, and the Stanley 43. The Stanley 43 is recommended for the size range of blades utilized on clearing saws, the others are too small. Sandvik and Husqvarna both sell a small tool to set their blades which incorporates a fixed set gauge. The Stanley is fully adjustable.

3.4 Blade Sharpening

Under normal conditions, an experienced worker would be required to either sharpen or change blades at least twice during the average working day. Both on-site and off-site sharpening were experimented with.

3.4.1 On-site Sharpening

(i) Filing: In-field sharpening is accomplished with round files in the same manner as with sawchain. Only blades specifically designed for field sharpening (such as the Husqvarna Maxi-blade) can be sharpened this way. See Appendix 12.3 for manufacturers' filing instructions.

(ii) 12-volt Portable Grinders: One other tool tried on-site was the Oregon 12-volt electric grinder ($40), using both the 7/32-inch Oregon stone and the better-quality Grandburg stone. Blades are sharpened at the vehicle using the battery as the power source. The unit removes material far too slowly (much slower than a file), and severely overheats before a damaged blade can be resharpened.

Other portable grinders such as manufactured by Grandburg Industries may fare better. The Simington sharpener (Simington Products Co., Star Route 141, Chilquin, Oregon 97624) is a high-quality portable grinder that uses a cutting disc rather than a long narrow stone. Although intended for use on a chainsaw, a simple jig would allow it to reshape and/or resharpen maxi-style blades in the field.

3.4.2 Off-site Sharpening

Because of the damage to blades from working close to the ground, excessive downtime was initially experienced from on-site sharpening. Consequently an efficient system for off-site sharpening was developed which was used for the remainder of the project.

(i) Tools: For hooked teeth (and also for the flat tops of maxi-style blades) the only tool I use is a 7-inch metal-cutting abrasive blade reshaped to a rounded edge. Any size would work. It can be mounted on a radial arm saw locked into the fully extended position, but any arbor with a power source would suffice.

(ii) Discussion: The 80-tooth blades are the most difficult to sharpen for two reasons: the small teeth heat quickly and burn readily, and there are a large number of teeth to sharpen.

The larger-toothed blades (usually thicker too) are far easier to sharpen. Care must be taken not to burn the tips, but material can be removed very quickly from the rest of the tooth.

Often, blades that hit rocks are missing as much as the top 1/8-inch of the tooth (an extreme case). Those blades essentially need reshaping rather than resharpening. However, with practice, this will take only ten to twelve minutes per blade and can be done entirely freehand. The Stihl 10-inch, 50-tooth blade was used throughout the length of the project and was resharpened many times. It is now a 9 1/4-inch blade and still performs very well. The teeth are surprisingly consistent in shape and size after so many freehand sharpenings.

(iii) Sharpening Instructions: While sharpening, the blade is held freely in the hands, while the grinding disc is stationary on an arbor.

Grind the front of the tooth first, removing just enough metal to expose a fresh cutting edge. Use only a little sideways pressure, but

cut the gullet deeper each time to compensate for the lost top of the tooth. Keep the angle at about 20-30 degrees to the edge of the blade, similar to a chainsaw tooth. Cut every second tooth to the same angle, using the same amount of pressure for the same length of time. Probably 1-2 seconds is adequate.

Turn the blade over and grind the teeth on the other side. Mark the first tooth done on each side (a crayon works well) so you know where to stop and don't grind the same tooth twice.

There should never be an oxide stain (blue of buff) after grinding. If there is, slow down, especially when working near the tips. Burnt blades lose their temper, won't hold an edge or set, and are consequently ruined.

Cutting the back of the tooth is a more delicate operation because the angle has to be changed for the curve of the back. But the shape of the back is also not critical till the tip of the blade is approached. Start with a deep and quick cut into the gullet to deepen the tooth. There is a lot of metal to carry the heat away, so the blade is unlikely to burn and material can be removed quickly. Roll the shoulder of the blade onto the flat of the cutting disc, gradually slowing down and decreasing pressure as the tip of the tooth is approached. Make sure there is always a slight positive clearance; the tip of the tooth should be the first into the cut.

It sounds complicated, but is easily done with practice. Clearing saw blades do not need the accuracy of a tablesaw blade so a rough and crude sharpening will suffice.

(iv) Recommendations: Use an inexpensive "skilsaw"-type blade (hooked teeth), with the hole bored to fit the 20-mm arbor. Sharpen with a thin metal-cutting abrasive blade being careful not to burn the temper, and set to 2-3 times the blade thickness. Sharpen blades off-site

(unless portable equipment is available), and change to sharp blades in the field as required. Alternatively, blade sharpening could be contracted out.

4. HARNESSES

The purpose of the harness is to support the clearing saw securely and comfortably. There is considerable variation in how well both are achieved with the various designs. Almost all harnesses have an emergency release mechanism, which also varied in its effectiveness. Four different harnesses were used and assessed. A short review of each follows.

4.1 Stihl Harness

Essentially only a single canvas strap over the opposite shoulder, the Stihl harness is not really a harness at all. The Stihl FS08 is a heavy saw, and several hours of use with the single strap produces a "hard list to port". Operator fatigue was high, and the straps were subsequently replaced with proper harnesses. Not recommended at all.

4.2 Shindaiwa Harness

The Shindaiwa harness was found to be adequately comfortable for continuous use, but several design flaws showed up. The catch on the harness is not a positive locking device such as the snaplink on other harnesses and requires continuous pressure to stay connected. Consequently it often came undone in use, usually when the saw was lifted and the weight came off the harness such as during a high clearing cut. This poses not only a nuisance but a significant hazard as well.

One operator, (5' 7" in height) found the adjustment range to be inadequate, (more suited to taller people), but was likely trying to adjust for a similar operating angle as the Swedish designs (see saw

reviews).

The clip connecting the harness to the saw seems awkward at first, but proves to be secure, and with practice, easy to operate.

The safety quick release was both easy to operate and quick to release. Only twice did the release trip unexpectedly. Once was during a fall; the operator had pitched head first towards the blade and the saw came disconnected - a highly hazardous situation. It was generally agreed that a better release mechanism is neccessary.

Unlike other harnesses, the Shindaiwa does not provide protection where the saw rides against the leg. Rather, it relies on padding on the saw itself which is considered inadequate.

Most of the crew considered the Shindaiwa harness less comfortable than either the Jonsereds or Husqvarna. In general, it was adequate but not recommended.

4.3 Jonsereds Harness

The Jonsereds harness uses wide plastic webbing to spread the weight comfortably across the shoulders. The range of adjustment appears to be adequate for a wide range of operator heights. Good thigh protection is achieved by the use of both a padded protector for comfort and a stiff plastic plate to prevent a pressure point.

The connector for the side strap on the harness provides a positive connection as does the connection from harness to saw, but the latter was a bit awkward to operate. It would be worth obtaining the Husqvarna connector as a spare part and substituting it.

The harness incorporates two safety quick release mechanisms: one at the saw connection that drops only the saw, and a complete disconnect to drop both harness and saw. (Some models have only the complete

release.) The saw release is essentially the same as on the Shindaiwa, with the same associated problems of accidental release. The complete release uses a spring-pin through a post to hold the front of the harness together, with a pull loop attached. On several occasions the release cord got caught and accidentally released. This hazard could only be eliminated by a unique design such as the Husqvarna release which eliminates the loop of cord that can get snagged.

In general, the harness was judged comfortable and adequate but with the major safety hazard mentioned could not be recommended.

4.4 Husqvarna Harness

The Husqvarna harness uses padded shoulder straps and a padded side strap to achieve a high degree of comfort. The range of adjustment is excellent, and due to a unique front yoke equalizer, the weight rides evenly on both shoulders. Good thigh protection is achieved by the use of a stiff plastic pad and soft padding.

The attachment point is a typical example of the brilliantly ergonomic design that is characteristic of Husqvarna. The saw is easily connected by simply dropping the saw support ring onto the hook. A lock mechanism secures the saw well, yet with one hand the lock mechanism is easily released and the saw lifted out. The snaplink connectors on other harnesses could be finicky even with both hands operating the mechanism.

The safety release is excellent as well. Pulling the edge of the chest plate forward releases the saw and all harness connections.

The Husqvarna harness is expensive ($100 Can. 1985) and elegant. Highly recommended.

5. SAFETY CONSIDERATIONS

5.1 Safety With the Saws

5.1.1 Safety Features

The clearing saw is inherently safer than the chainsaw. The saw blade is held at a safe distance and kickbacks are always to the right, safely away from the operator. The secure harness connection of the clearing saw does not allow the operator's feet or hands to get near the blade. There is also a quick release mechanism designed into most harnesses that allows instant divesture of the saw when required.

As with any potentially hazardous tool, proper training is the major element in achieving safe operations, and is dealt with separately.

The two most important safety rules of clearing saw operations are:

1. Always approach the operator from within his or her field of vision, and
2. Keep the blade nut tight at all times. A loose blade flying free at 10,000 rpm would be extremely hazardous to operators and bystanders.

Workers should be issued loud whistles and always work in pairs in the "buddy system". A 10-meter safety zone between operator and bystanders should be maintained.

5.1.2 Accident Rates

A comparison of accident rates among users of clearing saws and chainsaws conducted by the Professional Forestry Inspection Bureau of Sweden[4] supports the inherent safety advantage of clearing saws, with less than one-fifth the accidents.

There were no time-loss accidents during the approximately 150 worker-days of the project.

It was initially suggested by BCFS personnel that retreating a previously cut area would be hazardous from the multitude of small stumps. However, after working in an area cut 2 1/2 years before, it was obvious that the stumps did not pose a hazard to workers, and the previous brush had flattened sufficiently from snow and decay so as not to pose a problem with mobility.

High accident rates claimed and supported by some studies[5] have not manifested in actual field operations with chainsaws.[6,7]

5.1.3 Noise

Hearing protection is essential to avoid hearing damage while operating the saws. Sound levels are similar to a chainsaw, with additional high levels of high frequency noise from the blade. The selective nature of hearing protectors (i.e. they attenuate the high more than the low frequencies) leaves primarily the sound of the motor audible to the operator. For nearby personnel, the intensity of the high frequency noise is quickly attenuated with distance, and again it is the low-frequency sound of the motor that carries. In a populated area where it is desirable to keep noise as low as possible, the Husqvarna 244R would be the saw of choice.

5.2 Other Safety Considerations

5.2.1 Workers' Compensation Board Requirements

The WCB classifies clearing saw operations as an "A" Hazard, and the requirements vary depending on crew size and travel time to hospital. For a maximum crew of 5, more than 20 minutes travel time from a hospital (as most clearing contracts will be), the requirements are minimal: #2 Unit First Aid Kit, 3 blankets, and Survival First Aid training (which was supplied by the sponsor for all crew members).[8]

5.2.3 Wasps and Biting Insects

The greatest on-site hazard proved to be the numerous ground nests of the yellow-jacket wasp, for which avoidance is the best solution. After being stung once, workers become very alert to the problem. When a nest is spotted, the area should be well flagged and a safe distance maintained during the heat of the day when nest activity is highest. It is recommended that a separate colour of tape be reserved specifically for that application. In the cool morning, when nest activity is minimal, the area can be approached cautiously and cut in complete safety.

Tree nests pose the logistical problem of how to safely cut the host tree and the adjacent area. Possible solutions include insecticidal bomb, non-treatment of the area, protection suits for such areas, and for immediate results, a shotgun.

First aid for stings should consist of cold packs applied immediately to reduce swelling, and antihistamines to reduce allergic reactions. Any workers with a serious allergy to wasps (or other stinging insects) should avoid working in such sites.

Other biting insects, mainly black flies and no-see-ums, were not a problem until late summer, when all insect activity is highest. Insect repellent (DEET) solves the problem, but often the physical activity and saw fumes are sufficient protection.

5.2.3 Exhaust Fumes

Exposure to exhaust fumes is reduced by the back-pointing muffler system and the worker progress through the area. It can be further reduced by using 100-1 oil in the gas mix.

All saws have effective anti-vibration mounts for the handles, so white finger disease would not be likely to result from extended use.

5.3 Fire

Because of the research nature of the project with pre-determined cutting times, work continued through the fire season while other forest operations were shut down. The presence of large amounts of dry brush on the ground and the neccessity of handling gasoline for the power tools created great concern for fire hazard.

5.3.1 Equipment

Fire-fighting equipment and training, including the optional pump unit, were supplied by the BCFS District Office. Equipment requirements are specified by the Forest Fire Prevention Regulations of the Forest Act.

The small extinguishers carried by the crew for saw fires were the "Twin Jet" variety, with two parallel cylinders for a flat profile. Belt pouches come with them but have inadequate clasps, and the built-in belt clip is too fragile to be used. They were most often carried in a back pocket where they are secure but uncomfortable.

In the event of a fire (or serious injury) a two-way radio capable of reaching the local District Office would be the best means to give an adequate and immediate response. Because of the large amount of tinder-dry material on site, it is doubtful whether the crew could have suppressed a fire if one had caught hold. It would have taken a minumum of 1/2-hour to reach a telephone over the rough road, and the only vehicle and one crew member would have had to be sent for help.

5.3.2 Prevention

Several preventive measures were taken, such as refueling as much as possible on the road and away from fuel tanks and cut brush. All cut brush was hauled a safe distance away from the road to reduce roadside fire hazard from vehicular traffic.

5.3.3 Response To Fire

We received conflicting advice as to the best response to a fire: from "get the hell out and call help", to the suggestion that the pump and hoses be set up daily. It was our view that the extinguishers would be the most valuable tools for an immediate response. If a fire could not have been immediately suppressed, it would have rapidly spread and an adequate response would have required far more than our limited crew and equipment could have supplied.

There was no incidence of fire until the last day of the project when one saw caught fire. An immediate response extinguished the fire within seconds with the belt pack extinguisher and no damage to the saw resulted. The cause of the fire was attributed to poor design of the Shindaiwa saws. The exposed and consequently vulnerable priming lever became deformed and stuck open, causing the carburetor to continuously overflow. This overflow "feature", occurring even during normal operation, had earlier been noted as a potential fire hazard. The flimsy spark plug protector had also become deformed, allowing wear to the spark plug boot. It was a spark through the boot to the protector that ignited the leaking fuel.

It should be noted that such a fire would never have happened with the Swedish saws: all the exposed components damaged on the Shindaiwa are, on the Swedish models, protected under a cast alloy case. The Swedish-made gas tank is also an alloy casting that would withstand far greater heat than the plastic tank on the Shindaiwa before the contents would be released. The fuel would also leak out much slower from a melted hose rather than a complete tank failure.

It is frightening to see an exposed plastic gas tank enveloped in flames, and raises two obvious questions: how long would it take the tank to "melt down", and would the small extinguisher then be adequate to cope with the far greater blaze?

5.3.4 Recommendations

It is the first few seconds of response to a saw fire that are the most critical. When surrounded by dry brush and considering the consequence of failure, it is not redundant for all saw operators to carry two of the belt-pack extinguishers (in secure custom-made pouches). Similarly, the large extinguisher kept at the refueling station, although not required by regulation, is a more appropriate tool than a round-nose shovel (the only tool required) for fighting a gas fire. It could wisely be duplicated as well.

With the Shindaiwa saws, because of the unavoidable (but normally limited) overflow from the priming mechanism, an additional step should be added to the starting sequence: move the saw after priming or refueling, prior to starting.

A radio is recommended for future projects that require operations during the highest risk fire season. In the event of a fire, it would allow help to be summoned while the full crew could attempt initial suppression tactics. The vehicle could then also be kept on site for escape purposes if required.

6. CUTTING SPECIFICATIONS

Cutting specifications are an important element to consider when prescribing efficient and effective manual brush control programs. Specifications must not be too stringent for efficient operations, or too lax for effective clearing.

6.1 Discussion

Conflicting instructions were received regarding cutting specifications from the District Office of the Forest Service.

There was considerable difference of opinion expressed by most foresters polled as to the very necessity of conifer release on the Okeover site. Several professional foresters working with the Service or industry stated that, in their opinion, this site was not in need of treatment (with herbicides or cutting) except where the stem density had been grossly exacerbated by an incorrect timing of cut. One industry forester expressed concern only for the possibility of mechanical damage and double-topping from the alder rubbing against the firs.

While the Resource Officer, Silviculture specified avoiding cutting the naturally regenerated western hemlock, later liason stated that they were not suited to the site and could be cut or left with little consequence. Although there were few hemlock on site, it took a careful and conscientious operator (i.e. slow) to avoid them in the dense undergrowth because of their small size.

Initial specifications included cutting all species of "weed" trees, including the sparce arbutus. But because the arbutus did not comprise any competition to the conifers, (and for aesthetic reasons), it was decided not to cut them.

At one end of Unit B there was a great deal of logging slash dumped from above. Restocking was almost zero in those sites, but the alder had grown up through the slash and was subsequently specified to be cut.

Unfortunately for early crew morale, this was the starting point of the cutting. It is difficult to maneouver through such debris with a gangly clearing saw, especially for untrained beginners. The combination of such difficult terrain and the overly-heavy Stihl saw with its inadequate harness was a misleading introduction for all.

Requiring such areas to be cut subjects workers to unnecessary hazard and frustration in unproductive work. A change in liason with the District Office later eliminated the requirement to cut amongst the logging slash. Adjacent areas with less debris were cut where conifer stock existed.

Similarly, the stump piles pushed into mounds by D8 cats proved to be another area that required excessive effort to cut. The piles were 40-60 feet across and up to 15 feet high. Although there were no conifers planted on them, the alders flourished because of the large amount of topsoil in the piles.

They occupied only about 5-10% of the test plots but took a disproportionate amount of time to cut. Again workers were exposed to far greater hazard than during normal operations on the ground. Much greater effort was required to clamber, balance and cut on the stump piles. Most foresters that inspected them agreed that the debris piles only needed to be worked around.

Below the road were a number of low, flat, and slightly boggy areas where the major ground cover was bracken fern growing very thickly to a height of about 4 feet. It too was to be cut. Although western red cedar was recommended for this area, only Douglas-fir was planted, which grew slower than above the road and were difficult to find amongst the ferns. (The naturally regenerated cedar, however, was up to 15 feet tall and could easily be avoided.)

Clearing small stems such as ferns requires a sweeping scythe-like motion, and even with great care, the stunted conifers were cut or damaged. Such operations would be more efficient with attachments such as the triangular blades or line trimmers that allow a greater swath. However, conifer damage would continue unless the crop trees are sufficiently tall to be easily seen.

Neither of the treatments would be likely to give adequate control of bracken fern; the rapid yearly regrowth would likely negate manual cutting as an effective control, and 2,4-D does not control bracken fern. With the change in liason with the District Office, the requirement of cutting the bracken fern was lifted.

6.2 Recommendations

In areas where the presence of logging slash has resulted in poor stocking levels, expending the labour to clear the brush with the increased hazard to workers cannot be justified. Such areas should be removed from the cutting specifications. Aerially applied herbicides allow those areas to be treated regardless of terrain conditions and offer that advantage. However, with low stocking levels, it may be redundant to conduct any treatment.

For slash piles, efficient cutting requirements should include cutting around the pile, and as far into the pile as can be easily reached, without walking onto the pile. Extra effort should be made to reach any stems that shade specific crop trees.

Where the brush cover is uniform in nature and crop trees are densely stocked, a cutting prescription for all stems is appropriate. In other areas, less stringent specifications should be prescribed for an increase in overall efficiency.

Cutting specifications for clearing saw trials for the California Forest Service required a 4-foot radius to be cut around each crop tree.[9] The radius is certainly too small to release conifers from a red alder overstory because of alder's fast growth rate, but individual tree release will be applicable in some sites and should be considered.

It is clear that the initial specifications for the Okeover site were too stringent. There is a need for standard criteria to determine cutting specifications.

7. CREW TRAINING

7.1 Discussion

Training is the first and most important step towards achieving safe and efficient operations.

Proper training was not included as part of the Okeover project. The operations manager and crew used the excellent booklet "Work Technique for the Clearing Saw", published by Husqvarna, as the basis of what training could be accomplished. (See Appendix 12.4.)

Good work habits and efficient technique developed as workers gained experience. Productivity increased quite dramatically from the ineffectual beginning to the end. The first set of research plots took three days to cut with four inexperienced workers; the final plots (of equal area and stand conditions) took only one day with the same-size crew. This approximate tripling of productivity was the result of several factors: better physical conditioning and increased experience being major ones. However, the greatest factor by far was proper technique.

A skilled clearing saw operator can control the direction of fall to a far greater degree than with a chainsaw for stems up to 6-inches in diameter. By utilizing the spin of the blade, the angle of cut, and a push or pull with the saw, the operator can both avoid working in a tangled mess, and to a lesser degree, can avoid covering conifers with brush. However, the techniques are not obvious and without training will take considerable practice to achieve. A lack of previous brushclearing experience is not a handicap to learning, because the technique and motion bear no resemblance to chainsaw use.

That concurs with the experiences of the Quebec Forest Service where the largest manual cutting program in North America has been initiated. The clearing saw is the major tool being utilized in that project. The forest service found that the inexperienced worker learns quicker than those experienced with chainsaws, and consequently, preference in hiring is given to the new trainee.[10]

7.2 Recommendations

A proper training program should be incorporated into clearing saw operations where the crew lacks experience or proper technique with these tools. The expense, in both time and money, would quickly be saved with increased efficiency and worker safety being achieved much earlier in the program. Training would also reduce the initial strain on operators and equipment.

Training should include:

- -Use and adjustment of the harness.
- -Balancing and adjusting the saw.
- -Refueling: safety and procedure.
- -Maintenance and repair of saw and blades.
- -Saw handling and cutting techniques.
- -Site factors and planning.
- -Safety.

8. COSTS

In any program with a large manual component, labour will be the greatest expense, and productivity and cost will be highly interactive.

8.1 Okeover Project Costs

8.1.1 Overhead

Although quality Swedish saws were requested (and promised), cheaper Japanese saws were substituted, ostensibly to save money by the Forest Service. However, because the supplier was unable to make delivery for the beginning of the project, saws were leased for a month by the District Office adding almost $3,000 of overhead, or more than the cost of purchasing new Swedish saws.

The entire cost ($2,000) of the purchased Japanese saws was also ascribed to this one project. That figure includes a large parts order intended to reduce down time, most of which remains unused as spares.

It should be noted that if quality saws had been purchased initially instead of the cheaper saws, the Forest Service would be left with usable tools still in serviceable condition instead of worn out saws unsuited to forestry work. Indeed, there is false economy in buying the "cheapest" tool for the job. In addition to the savings in capital cost is the savings in frustration, down time, and loss of productivity from unsuitable tools.

Other one-time-only costs (such as first aid and fire equipment) should also not be ascribed to the one project in projecting costs for this type of operation.

All these factors in the Okeover project would serve to skew the actual cost of $908.03/ha (as given in the Stand Tending Report) in the direction of being far too high and non-representative.

8.1.2 Labour

Actual on-site costs (i.e. crew labour) was substantially higher (+75%) for the Forest Service crew, a reflection of the higher wages paid.

NEED crew:

$$\frac{\$7179.89}{14.5 \text{ ha}} = \$495/\text{ha.}$$

Forest Service crew:

$$\frac{\$4339.89}{5.0 \text{ ha}} = \$868/\text{ha.}$$

Considerably greater overall costs would have been incurred if all project participants received Forest Service (or IWA) wages. However, some of the increased costs would have been offset by increased productivity from a longer work day, better equipment, experience, and more efficient cutting specifications.

8.2 Herbicide Costs

8.2.1 On-site Costs

Originally, $6950 ($350/ha) was budgeted for an aerial spraying of the Okeover site. This figure was considered to be too high by the R/O, Silviculture, who presented an estimate of $150-$175/ha ($3,000-$3,500) at the Environmental Appeal Board Hearing. Although no detailed breakdown of that estimate was supplied to the Board as for the manual cutting estimate, it can be assumed that only chemical and application costs are included in that figure.

8.2.2 Hidden Costs

There are many hidden costs associated with a chemical program that must be included to get an accurate comparison. Many of these hidden costs can be quantified (such as water monitoring), while others cannot (such as health costs).

Hidden costs directly associated with the use of herbicides include: the preparation of applications for Pesticide Use Permits by user agency personnel, review and processing by the Pesticide Control Branch, review and processing by the Inter-Departmental Pesticide Review Committee members (8), any inspections by Federal Fisheries and Environmental Protection Service personnel, meetings between Forest

Service personnel and concerned citizens, additional inspections by Forest Service personnel (from District, Regional, and head Offices) directly related to the herbicide program, preparation for public hearings, Forest Service representation at hearings, the cost of the hearings themselves, associated costs of the Environmental Appeal Board in reviewing and preparing judgements, and aerial drift and water quality sampling required as per conditions of the Pesticide Use Permit.

Although quantifying these costs accurately would be difficult and beyond the scope of this report, they are real just the same. All costs mentioned would not be incurred if a non-chemical technique is prescribed.

Additional costs will be incurred if any water bodies are adjacent to the spray site, with buffer zones of 100 meters commonly specified in permits. Those areas must be flagged for the helicoptor pilot and possibly treated with a non-chemical technique as well. It is the wetter valley bottom sites that offer the best growing conditions for both conifer and brush species. There is also the additional cost of assembling equipment and personnel for two distinctly different treatments. The 100-meter pesticide-free zones beside waterbodies will quickly add up to a large area that is excluded from the chemical treatment option. One kilometer of waterbody protection will "cost" 10 hectares of treatment area for each side of a stream protected.

There are other hidden costs as well, including political, social, and health costs. As well as being unquantifiable, many are controversial with no consensus as to their magnitude. The social cost of employment displacement is undeniable, but whether the social benefits of increased employment will offset any increased dollar cost of manual treatment becomes a question of politics as much as economics.

A 1981 report by the Comptroller General of the United States[11] analyzed cost data comparing aerial release with manual cutting, with and without the hidden costs:

> ...manual release is 91 percent more expensive than aerial release when comparing direct contract costs but only 29 percent more expensive when comparing total costs.

In the same manner that ascribing excessive one-time capital costs to the Okeover project is non-representative of true costs, ascribing most of the hidden costs to the one spray project would be similarly inappropriate. The Okeover site was particularly controversial and had more than its share of hidden costs. However, such costs as water and drift monitoring, permit issuance and review, etc., will essentially be constant hidden costs associated with the use of herbicides.

9. PRODUCTIVITY

Best productivity with any manual brushing program will be achieved only with a refinement of all elements of tools and technique. Production will always be more a function of site conditions than the choice of tools. Factors to be considered include stem density, slope, average stem diameter, and the amount of logging debris present that would hinder operator progress. On most sites a clearing saw will be a more productive tool than a chainsaw.

Because the NEED grant funding ran out about 3/4's of the way through the project, a crew was hired by the Forest Service to finish the cut in December of 1983. After initial experimentation with the Shindaiwa clearing saw, the Forest Service crew chose chainsaws instead. A useful comparison can be made between the productivity of the two crews.

It became readily apparent early on in the research project that actual productivity and costs would not be representative of typical brushing and weeding contracting costs, consequently extensive records were not kept of productivity. However, an exact record of actual on-time for the saws for one typical day of the NEED crew gave an average of about 4 hours/worker. For calculating the productivity of the NEED crew it was assumed that a 7-hour day was worked, which with downtime, breaks, and access time, is a fair assumption.

The Silviculture Assistant who prepared the Stand Tending Report calculated the productivity of the two crews as follows:[12]

NEED crew:

$$\frac{14.5 \text{ ha}}{833 \text{ hrs}} = 0.122 \text{ ha/wd.}^{*}$$

Forest Service crew:

$$\frac{5.0 \text{ ha}}{302.5 \text{ hrs}} = 0.116 \text{ ha/wd.}^{*}$$

It appears that productivity was about the same, but there are a number of factors that could skew these figures either up or down:

In calculating actual worker-days on site for the NEED crew, allowances could be made for the extra hired help and first aid and fire training. But time spent gathering baseline data could not be separated, and occupied considerable time. Plot measuring was not required of the Forest Service crew. This factor would skew the NEED crew's productivity upwards.

Excessive downtime and lower productivity was experienced by the NEED crew from the inappropriate tools. That was not allowed for and would skew their productivity upwards.

Filing sawblades on-site initially accounted for excessive downtime for the NEED crew, but was later eliminated by off-site

*Worker-day

sharpening, a much quicker process. It would be useful to compare relative sharpening times required by the two cutting tools, but not enough information is available.

Another important variable was access time. The rough access road was repaired after the termination of the NEED project and before the beginning of the Forest Service crew operation. Considerable time savings could be expected with the vast improvement in access. This factor would also skew the NEED productivity upwards.

Of the total area cut by the NEED crew, 7.68 of 14.5 ha (53%) was previously cut and had coppiced. Of the total area cut by the Forest Service crew, 2.281 of 5.0 ha (46%) had been previously cut; about the same proportion.

All crew members of the Forest Service crew were experienced with chainsaw cutting operations, whereas the NEED crew had no previous experience with clearing saws and adequate training was not available. An improvement in initial productivity of the NEED crew would have been expected if either were available.

The NEED crew received less than 1/2 the wages of the Forest Service crew, which is not a stimulus for maximum productivity.

Because of the confounding factors listed above, no definitive comparison can be made between the productivity of the two crews with their different choice of tools; a time-motion study would be required for an accurate comparison. However, it is obvious that productivity is similar, and with the improvement in several factors discussed above, clearing saw productivity could be greater.

With the exclusion of excessive capital costs, and allowing for the factors above, this project would likely have been closer to the average figure of $530/hectare for manual brushing in similar areas.[13]

10. CONCLUSIONS

Manual brush control methods are a minor but integral part of the provincial Vegetation Management program. Of the manual cutting methods presently available, the clearing saw is superior to the chainsaw due to improved worker safety and productivity. Selection of quality tools, adequate training, correct timing of cut, and close-to-the-ground cutting specifications will all contribute towards a successful program.

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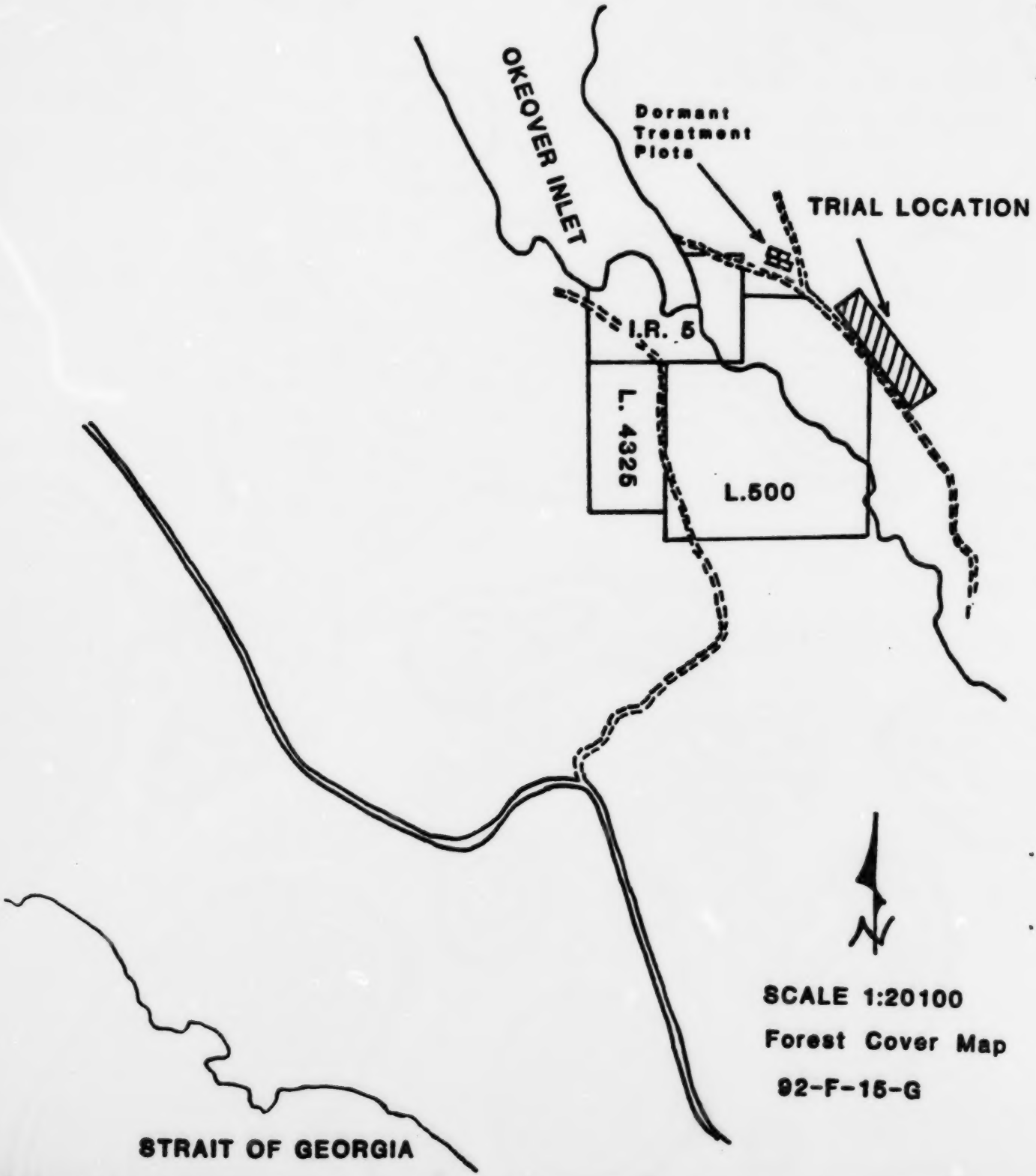
APPENDIX 12.1 TRIAL LOCATION



Appendix 12.1 Trial Location

APPENDIX 12.2 SITE DESCRIPTION AND HISTORY

The 20-hectare site is located about 16 km N.W. of Powell River, B.C. and is comprised of two units distinguished by differences in both treatment and location. Unit A is above the transecting road and Unit B is below. Elevation of Unit A is 30-120 meters, Unit B, 30-60 meters, with an average slope of 15-30% and a S.W. aspect. The site varies from quite dry above to boggy below. All 1983 test plots were in Unit A.

The timber on the Okeover site was harvested prematurely because of the presence of root rot (Phellinus Weirii), and was consequently clearcut in 1976 through 1978.

Site preparation in the summer of 1978 included scarification and root rot treatment. All stumps in Unit A (14.2 ha.) were pushed into piles with D8 cats to isolate the fungal infection. No mechanical site preparation or root rot treatment was conducted in Unit B.

Replanting was given a high priority because of the inevitable brush problem from the extensive scarification, and the site was subsequently planted in March, 1979.

Unit A: Fir (species unspecified) was prescribed for restocking Unit A and the site was planted with a 50/50 mixture of Douglas-fir (Pseudotsuga menziesii) and Grand fir (Abies grandis) except for 1.0 hectare that was mostly filled in 1981. An overall survival rate of 85% was measured in May, 1980 with most mortality ascribed to dry soil conditions at the time of planting.

Unit B: Western red cedar (Thuja plicata), a root rot resistant species, was prescribed for Unit B where no root rot treatment was carried out. However, 7,000 Grand fir, a root rot susceptible species were planted at 1200 trees/ha.

APPENDIX 12.2 Site Description and History (Continued)

A survey of the site in the fall of 1980 showed that alder had efficiently regenerated in the disturbed soil layer. A contract was let in winter of 1980 to cut about 9 hectares of the densest brush with chainsaws.

Little confidence was expressed in the Stand Tending Report for the long-term efficacy of that treatment with considerable resprouting anticipated: "Alder will have to be recut in 1-2 years."

A conifer release check conducted in July, 1981 confirmed the problems with alder resprouting, with an average of six sprouts per stump. Alder height had exceeded conifer height in one year.

In December 1981, a Pesticide Use Permit was applied for to aerially spray the site with a 2,4-D ester by the Resource Officer, Silviculture, and a permit was issued April 22, 1982.

The proposed spray program became highly controversial within the nearby communities and the issuance of the permit was unsuccessfully appealed to the Environmental Appeal Board.

Negotiations and opposition continued until, in January 1983, the decision to conduct a manual brushing and research project was announced.

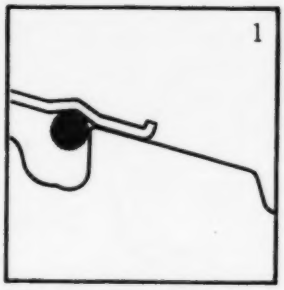
12. APPENDICES 12.3 AND 12.4

12.3 MANUFACTURERS' FILING INSTRUCTIONS

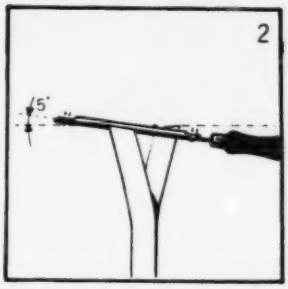
12.4 HUSQVARNA CLEARING SAW TECHNIQUE

Filing the Maxi clearing saw blade

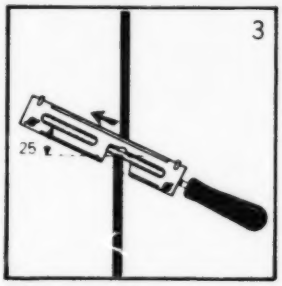
A correctly filed blade is essential for effective clearing and to avoid unnecessary wear on the blade and clearing saw. Make sure you use a good support for the blade when filing. Cut a tall V-shaped stump, for example.
Use a 5.5 mm (7/32") round file together with the file holder, type Oregon (501 58 02-01).



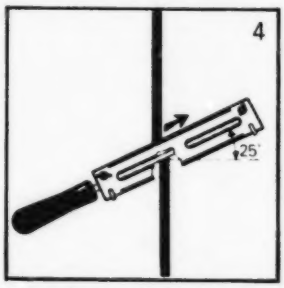
Filing should normally be carried out on the front edge of the tooth only. Make sure that the file holder is held firmly against the rear edge of the tooth.



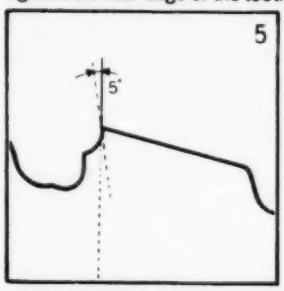
Hold the handle of the file just below the horizontal plane (5°).



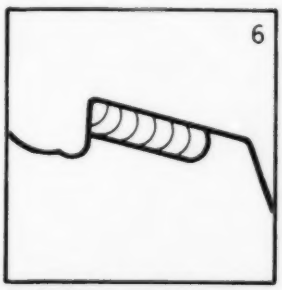
Filing angle 25°.



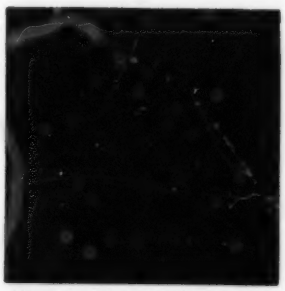
File each alternate tooth to the right and to the left.



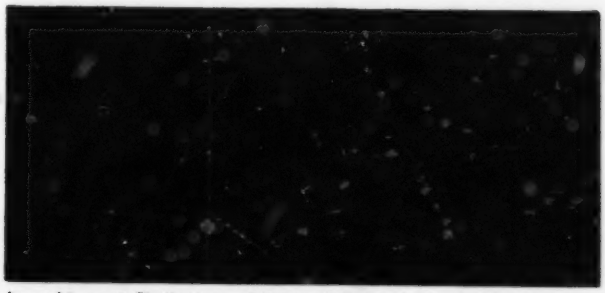
Check that the front edge angle is 5°. Harder types of wood or thicker stems might necessitate a smaller front edge angle. In this case, press the edge of the file holder harder against the rear edge of the tooth when filing and allow the file to work slightly higher up.



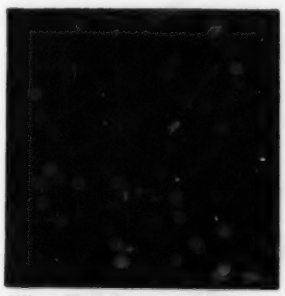
As the blade wears down, file it as shown in the diagram.



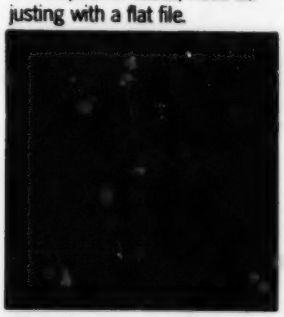
When the blade has been severely damaged by cutting into a rock, the top of the teeth might, in exceptional cases, need adjusting with a flat file.



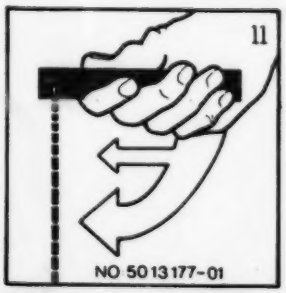
In sucht event, file the tops of the teeth first before using the round file. The tops must be filed equally on all teeth.



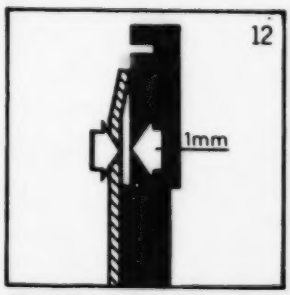
When filing the tops of the teeth, the handle of the file must also be held slightly lower.



When the tops of all the teeth have again been filed straight, sharpen them with a round file as shown in diagrams 2–5.



Adjust the set when the teeth have been filed down to half their height. Use setting gauge 501 31 77-01, pressing it downwards and inwards.

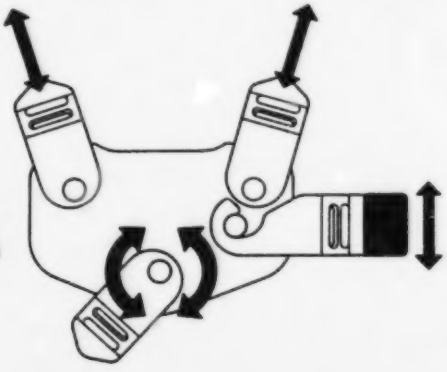


Check the set. It should be 1 mm.

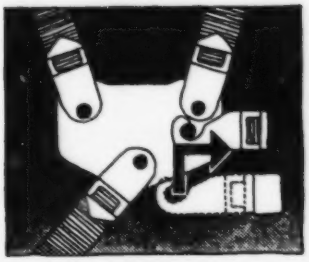
HUSQVARNA CLEARING SAW HARNESS WITH LOAD EQUALIZER

- Adjustable four-point strap attachment provides automatic equalization of the load on the shoulders.
- Wide shoulder pads of water-repellent synthetic fabric filled with polyethylene. Owing to the sealed cellular structure of the padding it does not absorb water.
- Chestplate padding of the same type as for the shoulder pads.
- Straps of polyester. Not continuous over the shoulder pads.
- Stepless adjustment of all straps.
- Easily replaceable thigh pad.
- Design-copyright suspension components for easy attachment and removal.
- Leight. Weighs only 700 grams.

A quick-release catch is built into the chestplate. Pulling the outer part of the chestplate straight out releases the left-hand shoulder strap and chest strap. You are completely free of saw and harness instantaneously.
NOTE: Do not use the quick-release catch unnecessarily.

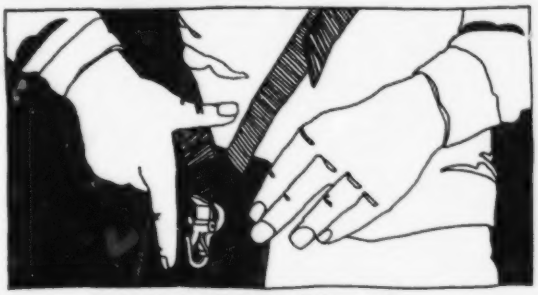


BALANCING AND ADJUSTING THE CLEARING SAW AND HARNESS



1. DON THE HARNESS

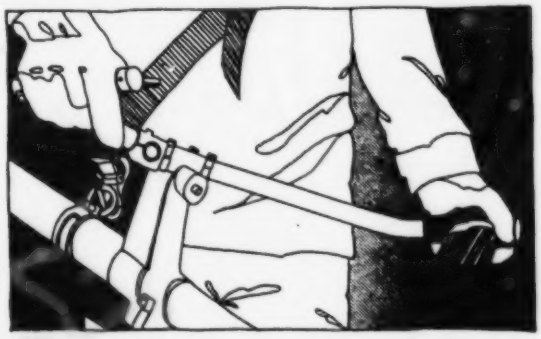
Attach the chest strap hook by inserting it straight up into the chestplate and then straight out as shown in the illustration.



2. COARSE ADJUSTMENT OF THE HARNESS

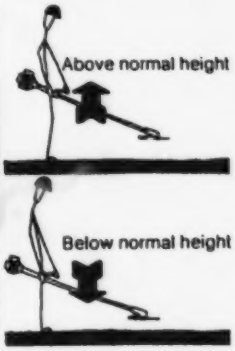
Adjust the position of the thigh pad until the suspension hook is about 15 cm below your hip bone. The clearing saw can now be hooked on to the harness for adjustment of saw balance.

The backplate and chestplate should normally be adjusted to about the same level.



3. FITTING THE CLEARING SAW

The saw clips easily in place. Lift it up with both hands and insert the clearing saw suspension loop in the hook on the harness. Turn the saw at an angle as shown in the illustration.



4. FINE ADJUSTMENT OF THE HARNESS

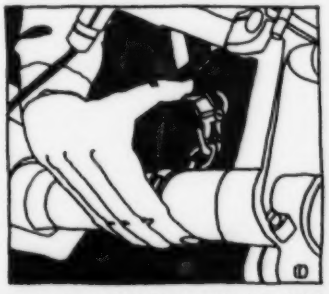
Adjust the harness until you have even pressure on both shoulders. Make sure the blade is directly in front of you when the saw hangs freely and you stand with your weight on both legs.
Adjust suspension height to the clearing work in hand. Use high suspension for uneven terrain strewn with boulders, and also for cleaning.
Use low suspension on level ground that is free from boulders or when particularly low stumps are required.

5. ADJUSTING THE BALANCE OF THE CLEARING SAW

Adjust the balance by moving the loop on the shaft casing.

- The fuel tank should be half-full.
- Stand on level ground.
- Allow the saw to hang freely from the harness and release the handles.

The blade should now be about 40 cm above the ground.



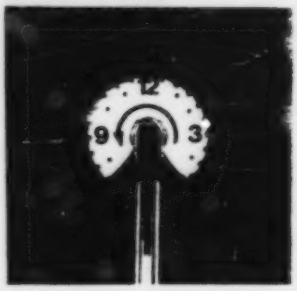
6.

The saw can easily be detached with the right hand only. Depress the catch with your thumb and hold it down while lifting the saw out of the hook.

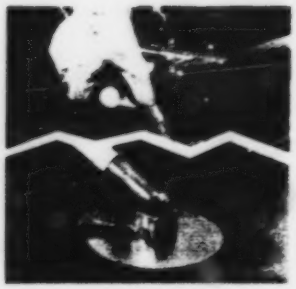
Husqvarna

Forest clearing Cross cutting and felling techniques

Fundamentals



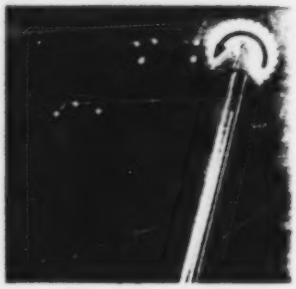
When talking about which part of the blade to use in different situations, imagine the blade to be the dial of a clock.
Cutting with the left-hand half tends to pull the clearing saw towards the stem. The right-hand half tends to push the blade away from the stem.



Open the throttle fully in good time. The blade should be rotating at maximum speed before biting into the wood.
Release the throttle between cutting operations but give frequent burst of the throttle to keep the blade rotating at cutting speed.

Stem thicknesses up to 3 cm

All the exposed part of the blade can be used.



Try to cut several stems at one go with the same saw movement. If there is enough room it may be advantageous to swing the saw from side to side.

Stem thicknesses above 3 cm

Soft sawing
Here you have good control over the sawing operation. Use this sector, then, as there is a danger of cutting into stone or nearby stems.

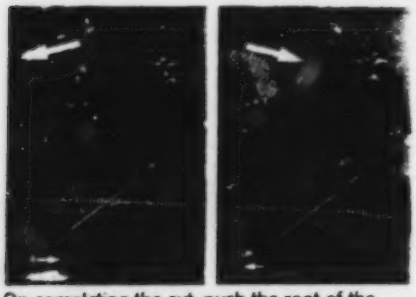
Caution
Cutting with this part of the blade will easily cause it to "throw" and jam and should therefore be avoided.

Direction of fall

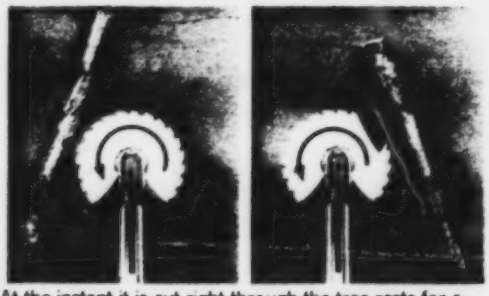
Uncontrolled felling
If thick stems are allowed to fall haphazardly in all directions in the uncleared area they will make subsequent work more difficult.

Controlled felling
With the technique we shall try to describe here, the trees can be felled so that they fall into the cleared area or into gaps in the stand. Subsequent work will then be facilitated.

Stem thickness 3–7 cm. The blade goes through in a single cut.



On completing the cut, push the root of the stem hastily in the opposite direction to the desired direction of fall. Do this by coordinating saw blade rotation, blade angle and feed movement.



At the instant it is cut right through the tree rests for a brief moment on the blade and is carried with it in the direction of rotation, the saw must be used in the following manner:

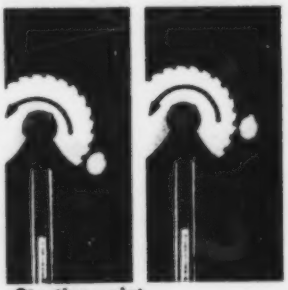
Right-hand side of blade.
Feed motion forward or to the right.

Left-hand side of blade
Feed motion rearward or to the left.

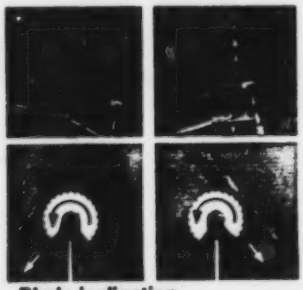
Caution
Always incline the blade to the left when using the pulling side. This will ensure that the stem slides off the blade. Otherwise it might press the blade down into the ground with the attendant risk of cutting into stone.

Forest clearing Cross cutting and felling techniques

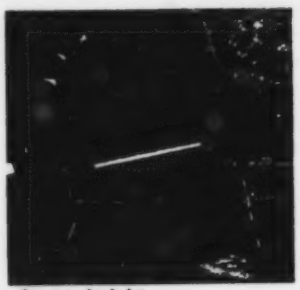
Factors affecting the direction of fall. (Stem thickness 3–7 cm)

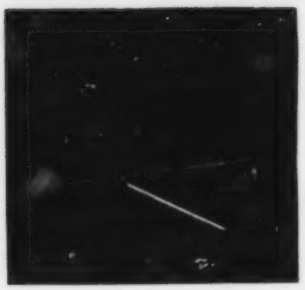


Starting point
The stem slides off the blade in different directions when cutting is started at different points on the blade.

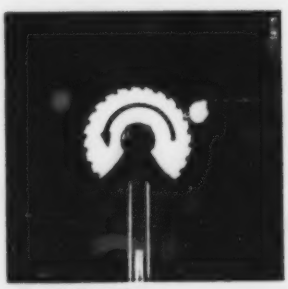


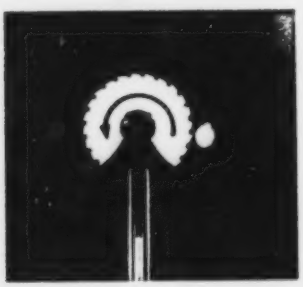
Blade inclination
The stem remains on the blade for different lengths of time, depending on how the blade is inclined.



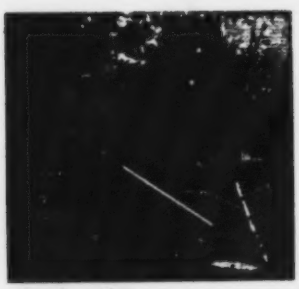


Stump height
By varying the stump height you change the fore-and-aft inclination of the blade. You then also determine how far the stem slides away before striking the ground.

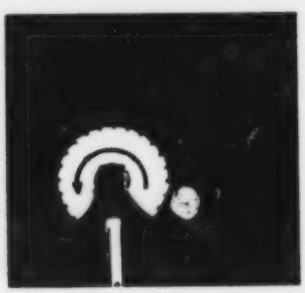




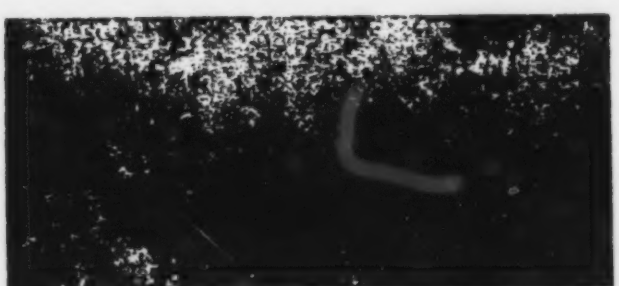
Feed direction
By moving the blade with a definite pressure in different directions, the blade's own feed motion can be reinforced or counteracted. In certain cases by such an amount that the "forbidden" section between 12 o'clock and 2 o'clock can be used.



Feed motion
To get the tree to fall in the desired direction, the end of the stem must sometimes be displaced fairly drastically. Variation in the feed motion is one of the factors determining how far away the base of the stem will move. You must never go to extremes and actually strike the tree.



Blade rotation
If the left-hand half of the blade is used, the base of the stem will be carried rearward. Using the right-hand half of the blade, the stem base will be carried forward. The exact direction will depend on how you allow the other factors to come into play.



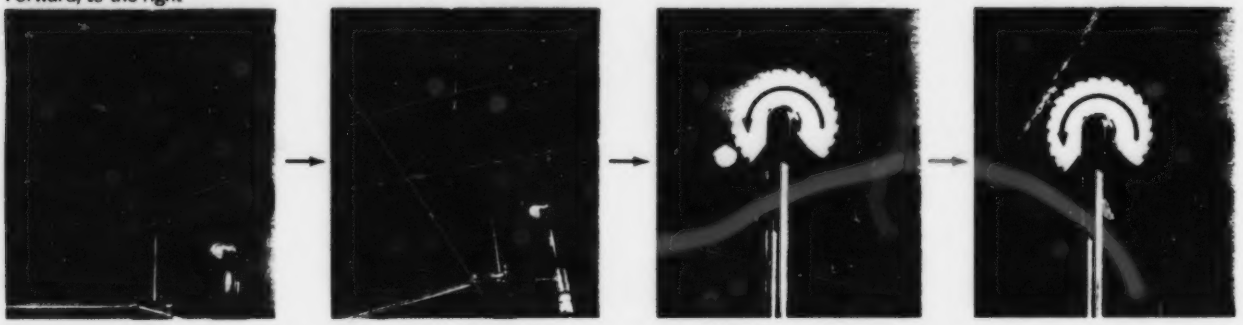
In practice, of course, other factors also affect the direction of fall. These include wind direction, the shape of the crown, the inclination of the stem and the position of other trees. Sometime these factors can be overcome, sometimes you will have to defer to them. Preferably, you should make use of them.

Forest clearing Cross cutting and felling techniques

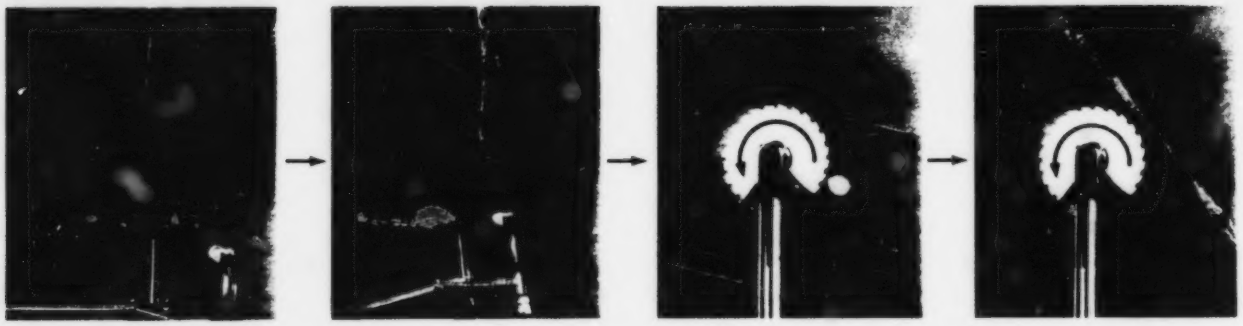
The three main felling directions (stem thickness 3–7 cm)

Intended direction of fall | **Angle of blade** | **Feed and starting point** | **Result**

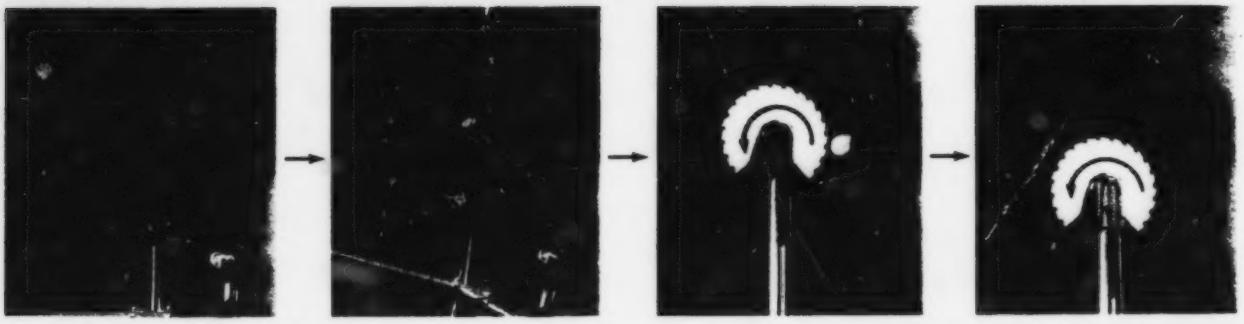
Forward, to the right



Rearward, to the right



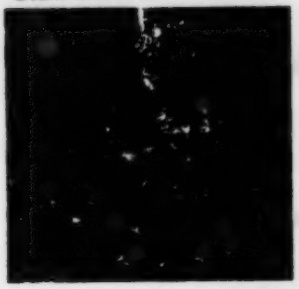
Rearward, to the left



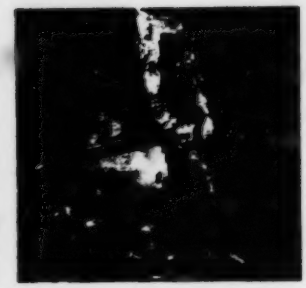
Felling forward to the left in exceptional cases

Forest clearing Cross cutting and felling techniques

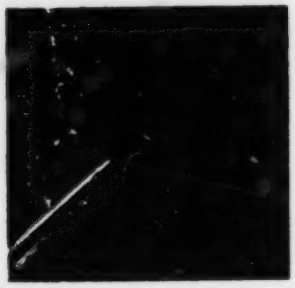
Stem thickness 7–15 cm



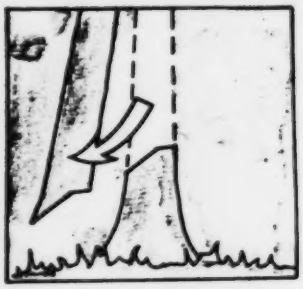
Make the first cut on the felling side of the tree. Assess the direction in which the tree leans.



Make the first cut shallow, just enough for the cut from the other side to reach through. If the first cut is too deep the tree might begin to fall and nip the blade.



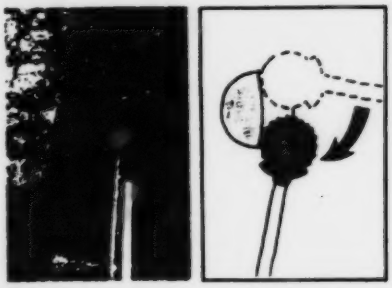
Saw through the tree with a cut from the other side.



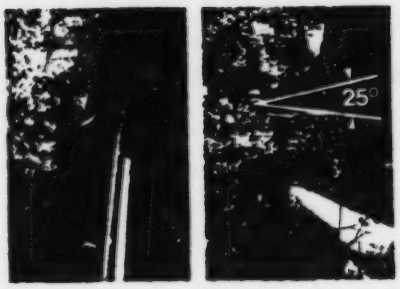
If you learn to cut with a high degree of precision you can angle both cuts so that the stem slides off the stump and the tree falls according to the same principles as for small trees.

Stem thickness 15–20 cm

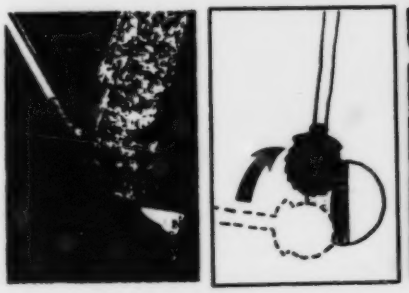
Upper notch. Pulling blade.



Lower notch, also with pulling blade.



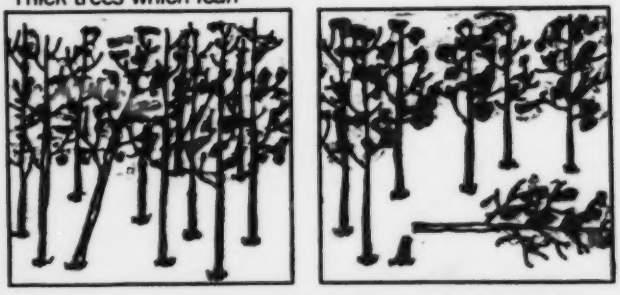
As deep a notch as possible with an opening of about 25°.



Change position and make the felling cut, also with a pulling blade.

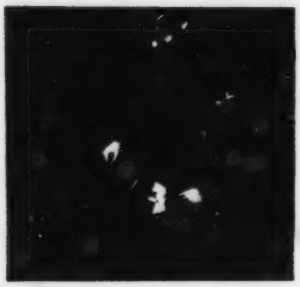
The tree can now be made to fall. The remaining fibres in the centre of the stump will be broken off by the weight of the tree.

Thick trees which lean

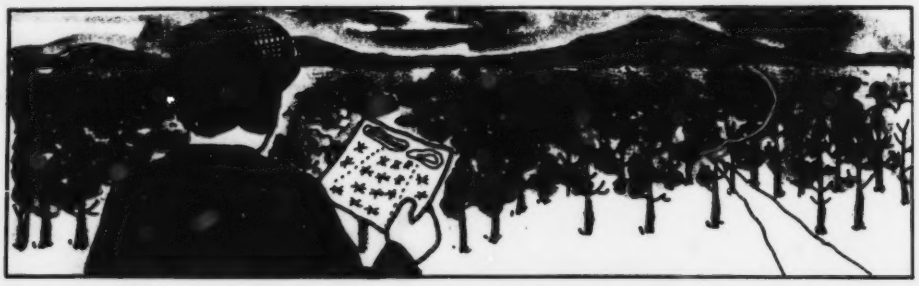


A large tree which leans may often be difficult and time consuming to fell against the direction in which it leans. For this reason, fell the tree in a direction towards which it is already inclined. But make sure that the area into which it falls has already been cleared.

Forest clearing Organizing the work



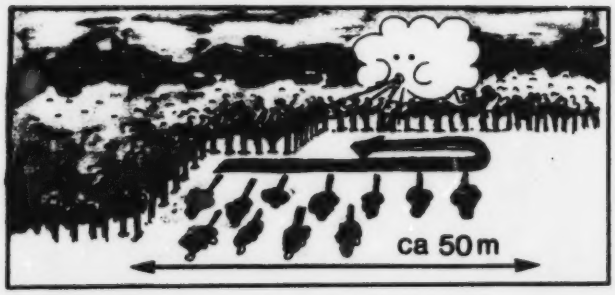
Make sure that your equipment is complete before you move out into the forest. Interruptions in clearing work on account of missing equipment are both costly and irritating.



Plan your work in advance. When working on large and unfamiliar tracts of land, a sketch showing boundaries, streams, roads, footpaths, etc. is a decided advantage.

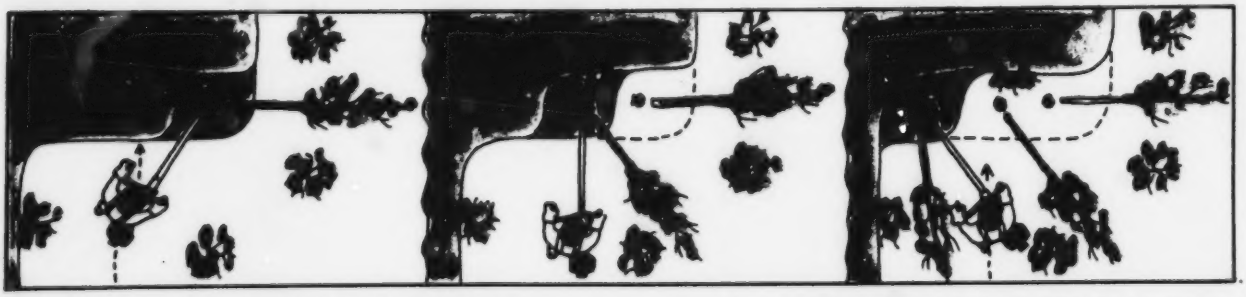
Before starting work, you should decide, or should have been given instructions, about the following

a. Which species of trees are to be favoured
b. How many trees are to be left standing
c. How the ground layer is to be cleared
d. How clearing is to be carried out in other respects.



Work systematically back and forth across the strakes. On sloping ground the strakes should be arranged transversely across the slope.
Also try to arrange the strakes crosswise to the wind so that the wind helps to fell the stems into the area that has already been cleared.

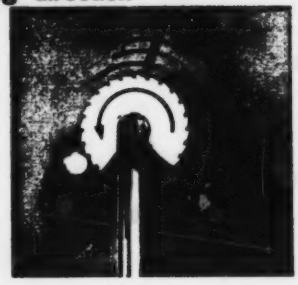
Use a working width of about two metres in every strake. Narrower if the stand is dense. Slightly wider if it is sparse.
Try to obtain straight strakes. It will then be easier to fell trees into the area that has already been cleared.



Begin at the outer edge and gradually work in towards the uncleared area. Try to fell trees so that they fall on either side of you and in such a way that you are not obstructed by fallen trees as you move forward. Get rid of the small stuff first.

Forest clearing Special situations

Trees leaning in the "wrong" direction

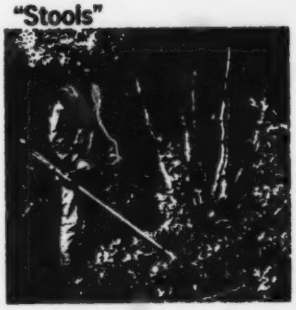


If the inclination is not excessive and the thickness of the tree is no greater than it can be sawn through with a single cut, saw through the stem fairly high up with a quick cut to get the stem over in the right direction.

Hanging stems

If you need to take down stems that are hung up the easiest way to do so is by slashing them down. It is best to cut from underneath with an upwards movement of the saw.
If you use a pulling blade you should twist the gear casing aside at the instant the cut is completed. Otherwise the top part might press the blade down onto the ground and damage it.

"Stools"



First clear all round the "stool".

Open up the stool by cutting off a few stems about one metre up where there is room to use the saw without danger of nipping the blade.

Then cut off the tall stumps closer to the ground. This will give you access to the rest of the stems which can be cut in the ordinary way.

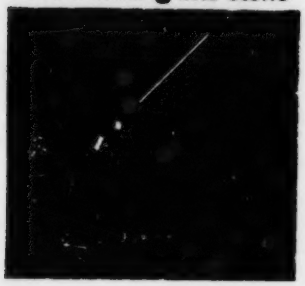
Cut low stumps in the outer parts of the stool or else you will have difficulty in reaching the middle.

Felling into uncleared areas.

Shrub half (A), which would fall into the uncleared area (B), should not be cut down until the area into which the stems will fall has been fully cleared.

Forest clearing Special situations

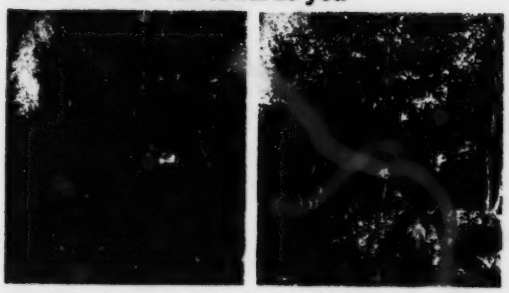
Avoid cutting into stone



If you see a stone, then cross cut at an angle so that in the event of a throw the blade will move past the stone.

If you see no stone but suspect that there is one, cut off a bit at a time so that you can see what is there when you apply the blade. This can save a lot of filing time.

Stems which fall towards you



The best way of avoiding a stem that falls towards you is usually by just twisting your body out of the way or stepping aside.

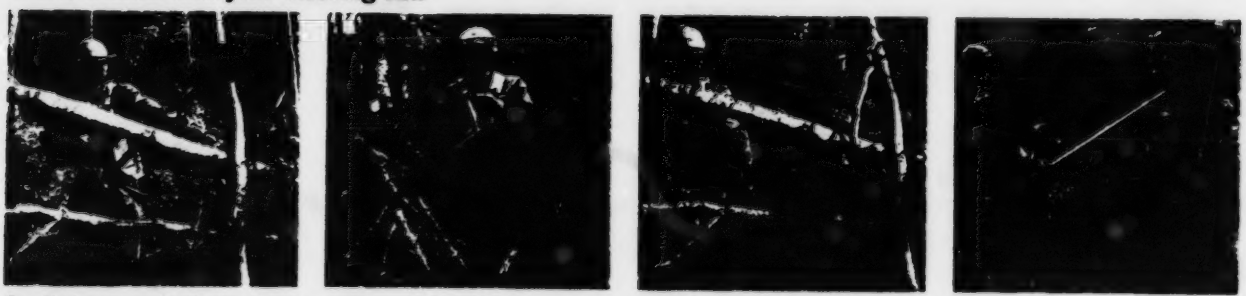
Cleaning the blade guard

First try to spin the blade backwards against a stump. If the obstruction does not come free, stop the engine and remove it by hand.

Check the results

Check that you have the right number of stems after clearing. This can be done most easily by counting the number of remaining stems inside a circular area of 100 m². This is obtained by using a length of string 5.64 metres long as the radius of a circle. Multiply the number of stems inside the circle by 100 to obtain the number of stems per hectare. Example: 17x100 = 1 700.

Make friends with your clearing saw



Familiarize yourself with it so that you can handle it with ease even in unusual and difficult situations.

Care and maintenance of the clearing saw

Daily

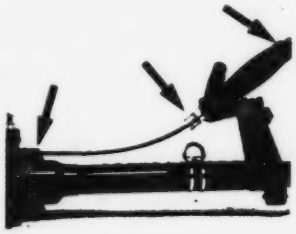
Clean the exterior of the saw.

Inspect the blade guard and the blade. Fit replacements if they have any cracks or other damage. Keep the blade sharp all day.

Clean the air cleaner.

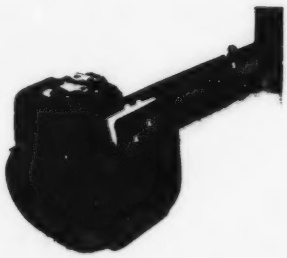
Make sure that all nuts and bolts are properly tightened.

Weekly



Lubricate the linkages and bearing points of the throttle control with thin lubricating oil.

Inspect the starter, starter cord and return spring.

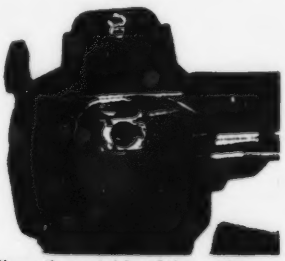


Clean the cooling fins on the cylinder and check that the air intake on the starter is not obstructed.

Check that the angular gear is 3/4 full of lubricant.

Monthly

Clean the fuel tank.



Clean the outside of the carburettor and the space round it.

Clean the fan and the space round it.